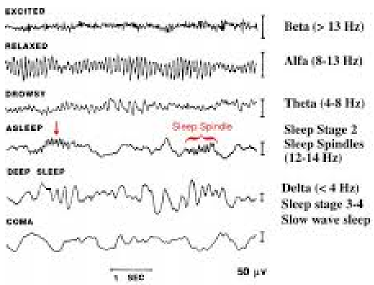
NeuroTronics

No.4
Differentials and Amplifiers
www.asmrstudio.com

Hooke's, Jacques Benveniste, Margaret Watts-Hughs, Margaret Chlandi, Angleo Mosso, Hans Jenny are pioneers in neuroimaging.

Electro Encephalo Graph

EEGs are a noninvasive way to look into the brain. The brain has complex bioelectric patterns. Alpha wave concentrations on the left motor cortex increase when you think about moving your right hand. Final circuit can also be an electrocardiogram (ECG), as a way to see your heartbeat trace. The circuit will use 3 electrodes - 2 to measure a voltage difference across your scalp, and one as a reference to ground. The circuit costs around $10 and can be integrated into thought controlled devices, or circuit can be stacked x10 or more and integrated with EEG software (openeeg.sourceforge.net) to become a full featured EEG. A breadboard.. - Wires - 3.5mm audio cable. - 2x 9V batteries for power.



instructables.com/id/DIY-EEG-and-ECG-Circuit

Capacitors: - 1x 10 nF, ceramic - 1x 20 nF, ceramic - 1x 100nF, tantalum - 5x 220nF, tantalum - 1x 1uF, electrolytic - 2x 10uF, electrolytic

Resistors: - 1x 1kΩ Potentiometer Adjust your gain on the fly. - 2x 12Ω - 1x 220Ω - 1x 560Ω - 2x 22kΩ 1x 47kΩ - 2x 100kΩ - 2x 180kΩ - 1x 220kΩ - 2x 270kΩ - 1x 1MΩ

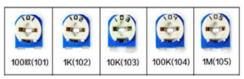
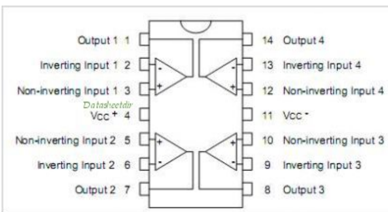


image: potentiometers

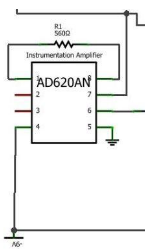
2x Quad Op-Amp - TL084CN

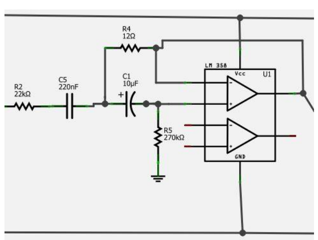
Any Op-Amp will do. You need 5 single amps, this one includes 4 in each chip. The TL084CN chip ports are shown packaged in a 14 pin integrated circuit. Chip is broken down to individual operational amplifiers to illustrate EEG function.



1x Instrumentation Amp - AD620AN

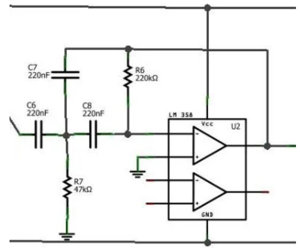
An instrumentation amplifier takes as its inputs 2 voltages, and outputs the difference between the two multiplied by gain (G). Perfect amplifiers would take as inputs 2.1V and 2.2V, and output 0.1V*G. The op amp common-mode rejection ratio (CMRR) is the the common-mode gain to differential-mode gain, ratio. G = 1 + 49,400 / Rg, equates to a gain of 89.2 with a 560 ohm resistor between pins 1 and 8. Active electrodes (ones that are not the ground electrode) will be connected to pin 2 and 3 (-IN and +IN). It is theoretically possible to use 3 op-amps when no AD620AN is available.

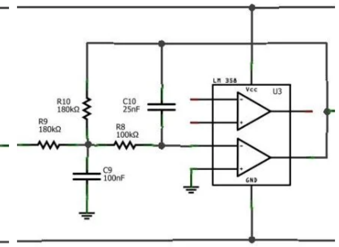




60 Hz Notch Filter

Notch filters reduce gain around 1 particular frequency. The biggest noise source in our system is centered at 60 Hz, due to power line interference. Even if you use batteries. If notch source signal or notch signal output is not centered at 60Hz to filter environment noise or filter out picked up and processed interference, try a 10 ohm resistor, or potentiometer, as notch can vary considerably.



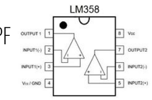


7Hz High Pass Filter (HPF)

The main focus is alpha/beta wave. Voltage also contains galvanic skin response as low frequency interference, obscuring brain data. A high pass filter (HPF) suppresses low frequency and passes high frequencies. Gamma/delta waves are about 8 Hz or less. HPF is two pole suppression on frequencies below 7.23Hz reducing them -71%. High frequencies approach a gain x1 (1:1 ratio). HPF Gain falls much faster than a simpler resistor/capacitor circuit. Double pole design reduces by x56 at 1Hz. A single pole reduces by factor x7.5.

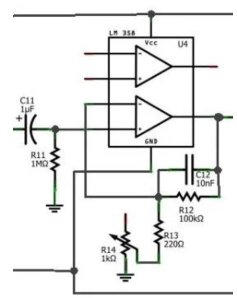
31Hz Low Pass Filter

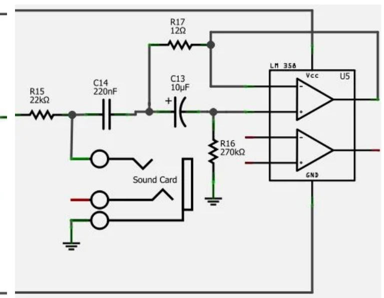
Beta wave information stops out at 30Hz, so filter out noise frequencies above that. The circuit design is very similar to the high pass filter from stage 3 - it has a gain of .71 at 31.23Hz, and decreases from there at a rate such that by 300Hz it has attenuated the data by about a factor of 100.



LM358 Substitute
100 dB Voltage Gain
500 μA || mA*
830 mW || mA**

*μA is micro amps, also mA
**μW is micro watts, also mW



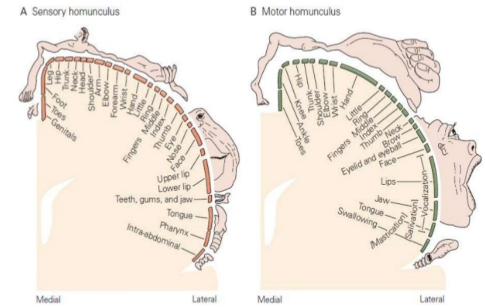


1 Hz HPF and Gain 83-455

Beginning this circuit is a High Pass Filter (HPF) that attenuates noise at frequency 1Hz (Fc = 1/(2*pi*R11*C11). Ending the circuit, the resistor and capacitor in parallel filter high frequencies (Fc = 1/(2*pi*10nF*100kΩ) = 160Hz on a low-pass filter). The non-inverting op-amp amplifier has gain G = 1 + R12/(R13+R14), (ignore the 10nF small value). The 220Ω variable resistor (potentiometer, pot for short) adjusts manually 0 to 1000 Ω . When pot is turned left, the gain is G = 1 + R12/(R13 + 0) = 1 + 100k/(220 + 0) = 455. When turned right, the gain is G = 1 + R12/(R13 + 1000) = 1 + 100k/(220 + 1k) = 83. Remember, this 83-455 gain is on top of the 89.2x gain from the instrumentation amplifier. Alpha wave amplitude varies from person to person, from about 10 to 30 uV. Using a middle value of 20 uV, this means the ending voltage reading could range from *83*89.2*20e-6 = .148V* to *455*89.2*20e-6 = .81172V.* Once you've started taking readings, adjust the potentiometer such that when you're not moving at all, voltages don't fluctuate offscreen (over 1V). It doesn't have to be maximized such that the amplitude is the highest possible without clipping - just know that if you make it too small, you'll increase the error incurred from digitally reading the data into the computer.

Another 60Hz Notch (and Into the Computer!)

To "set" GND, connect an electrode to your leg. All readings will vary from there, "0V". Use the computer's sound card to get the data in. we have to cut noise enough that the signal with noise does not spike above or below +1V and -1V, as this is the point where the sound card clips the data off. As we will be using +-9V through batteries to power the circuit, we also have to make sure that as our data is going through the circuit, it never peaks above or below this value.



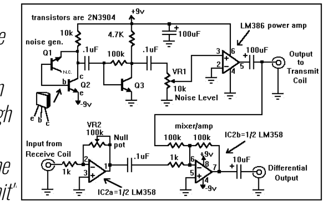
Homunculus : Brain Map

Brain regions map directly to mammalian functions. The somatosensory outer/neo cortex responsible for skin sensations, such as pressure, nociception, mechanoreception, heat, chemoreceptors and heat. The motor cortex responsible for motion, location and more!

Etymology: "tiny human beings produced artificially," 1650s, from Latin homunculus. *etymonline.com*

Implementation to Record Audio "Bio-Holograms"

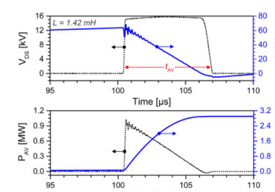
Recently, I came across a fascinating article at Bill Beaty's site, outlining Jacques Benveniste, a scientist who claims to be able to extract, and record chemical molecular signature frequencies. A coil receives noise altered transmitted by an optical hologram; here we use audio frequencies. NPN transistor Q1 is connected "upside-down" in avalanche mode generating white noise. Q1's noise current biases Q2's base, and Q2 amplifies the white noise signal. Q3 provides another noise gain stage. VR1 is a "volume" control; the signal through the wiper is variable and is sent to Integrated Circuit (IC1), a 100 mW audio power amplifier. The amplified output is sent to the output jack "transmit" coil. The transmitting coil broadcasts a white-noise magnetic field into the water sample. Some distance away, a "receive" coil picks up the white noise, which we presume is altered in intensity, frequency response, and phase, in small but measurable amounts. Op amp IC2a amplifies the receive coil', which attenuates with increasing distance from the transmitting coil. We uncover the small distortions in noise, by mixing the reference back in with the altered signal, but 180 degrees out of phase. Residual signals present in the differential mix are amplified by IC1b and sent to the output jack as the "differential output". Analogous to a transformer, the amplified IC2a receiving signal mixed (summed) against the original "reference" noise signal. The receiving coil phase (connection polarity) adjustable through amplifier gain potentiometer VR2 till signals cancel or "null" each other (phase cancellation). The null should be quite deep, and the assumption is the difference (differential) between the two signals represent the hologram being recorded, as interference patterns in film laser hologram technology.



amasci.com/freenrg/bioholo.html

The ependymal cells in the ventricle choroid plexus produce transcellular Cerebro-Spinal-Fluid (CSF) roughly 500 mL per day, 25 mL an hour. This is constantly reabsorbed, so that only 125–150 mL is present at any one time. Negatively charged chloride, and positively charged sodium, maintain electroneutrality, pumping out potassium and bicarbonate. CSF contains higher sodium and chloride concentration than blood plasma, but less potassium, calcium, glucose and protein.

en.wikipedia.org/wiki/Cerebrospinal_fluid



Single-Pulse Avalanche Mode Operation 10-kV/10-A SiC MOSFET

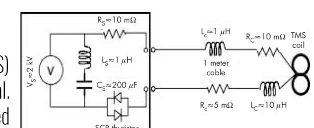
en.wikipedia.org : tinyurl.com/y37msvrf

Placing a MOSFET (Metal Oxide Semi Conductor, Field Effect Transistor) or other transistor types in reverse creates noise. This noise can be used a reference differential. Patterns passed into noise are compared to original source noise, thus a signal is found.

Transcranial Magnetic Stimulation (TMS)

researchgate.net : tinyurl.com/y23ejffy

A typical transcranial magnetic stimulation (TMS) circuit diagram. rTMS devices require FDA approval. Capacitors release charge rapidly into coils pressed against head.

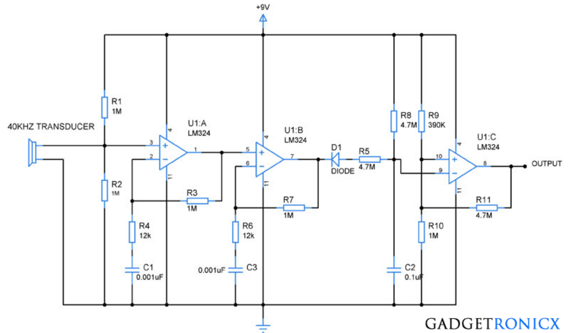


MAKE CONDUCTIVE RUBBER : Needed Paraffin or candle wax, Naphtha solvent from hardware store (Turpentine Alternatively), Silicone Caulk from hardware store, Corn starch from grocery store, Carbon Graphite powder. **Directions:** Add three parts graphite powder (by volume) to 1/4 part cornstarch to one part silicone caulk. A typical first mix would be 3/4 teaspoon of graphite to 1/16 teaspoon cornstarch to 1/4 teaspoon silicone caulk. Mix the graphite and cornstarch together with enough Naphtha to make a thick paste. Then add silicone caulk and stir to smooth peanut butter. **WARNING:** Naphtha is a sickly-sweet smelling solvent, mix with ventilation, as it can be absorbed by the skin, brain and lungs. Naphtha, evaporates extremely fast and in hours, most odor is gone, it is set to de-mold, and ready for overnight drying. Other solvents can take a day or two. **Other Mixes:** At about two parts graphite to one silicone caulk, the mix becomes usefully conductive. Adding more than 3 parts graphite reduces rubber flexibility.

ULTRASONIC RECEIVER CIRCUIT USING OPAMP LM324


40KHz

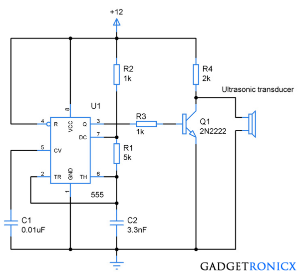
High Frequency (+20Khz) Ultrasonic sound waves are inaudible to human ears. Circuit uses a receiver (40 KHz transducer) converting ultrasonic waves to voltage. Signal is passed through a non inverting amplifier built using Quad Op amp IC LM324. Amplifier gain controlled using feedback resistor (R3) connected from output to the inverting terminal. Signal is further amplified in next non inverting amplifier. Output obtained from pin 7, then rectified through diode (D1) using Resistor (R5) and Capacitor (C2).



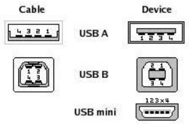
Final op amp wired as a comparator giving high output whenever an ultrasonic wave is detected by the transducer and low signal whenever there is no wave detected by the transducer. Used with a transmitter in obstacle avoidance and range detection with a microcontroller. www.gadgetronicx.com/ultrasonic-receiver-circuit/

555 40KHz Ultrasonic Transmitter

Bats, dolphins etc uses these waves to interact with the external environment. This circuit demonstrates constructing a simple 40KHz ultrasonic transmitter built around timer ic 555. Integrated Circuit (IC 555) is wired as an astable multivibrator oscillator. Configured to produce continuous 40KHZ serial square wave pulses. Output frequency governed by equation F= 1..44/((R2+2R1)C2). Circuit components R1, R2 and C2 are selected to give 40KHZ square wave as output.

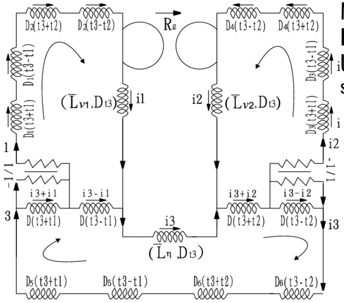


Gadgetronicx.com tinyurl.com/y5h23wmk



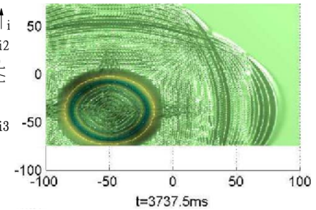
Shielded Cables and USB

USB (Universal Serial Bus) is a standard for computer communications. Use a knife to cut down a cable sheath, revealing the wires inside. Using a voltmeter, press a probe to a pin and each exposed wire until a connection is found. Aluminum cover wrapped around the wires protects signals from RFI (radio frequency interference) and EMI (electro magnetic interference). Wrapping wire around a non magnetic ferro core will dampen electrical signal spikes.



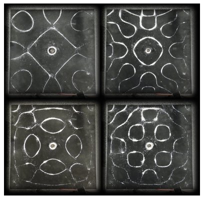
MODELING AND VISUALIZATION - TIME DEPENDENT SHALLOW WATER SYSTEM USING NON-LINEAR KIRCHOFF CIRCUIT

semanticscholar.org :: tinyurl.com/y5xg79g4



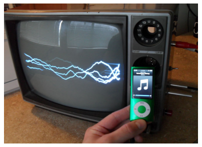
Circuit places inductors into water creating vibrations known as cymatics. Kirchoff provided net zero laws in electric circuits. Hans Jenny, a 1960's Swiss cymatics physicist youtube.com : tinyurl.com/y6kkj8l7

Chladni's Experiment: Cymatics in action. Take flat sheet metal, either circular or square, mount on a central stalk to a sturdy base. Sprinkle fine sand or salt. Use a Cello, Violin bow or build one from string and staff. Hold a corner to the square plate, stroking the middle, or stroke the circular plate 45° around from your finger. The sand bounces about on the plate until settling at nodal points (zero movement areas) producing intricate patterns. tokenrock.com : tinyurl.com/y5yczkmn



DIY CRT Oscilloscope

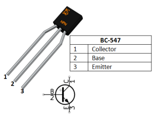
youtube.com/watch?v=e_PtushqEJA
instructables.com : tinyurl.com/y2kypfas



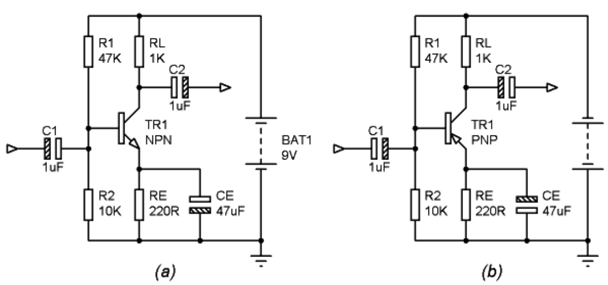
STEP 1: Identify the wires, inside wrapped around the CRT are two wire coils, one controls the vertical deflection of electrons, the other controls the horizontal deflection. Where these coils attached to the circuit board, desolder one coil. Turn on the TV (with cover replaced). If you see a horizontal line, you desoldered the vertical deflection coil. If you see a vertical line, you desoldered the horizontal deflection coil. Now desolder the horizontal coil, and solder it to where the vertical coil was. Really, it's an oscilloscope now. I use mine to watch the waves created by music from my mp3 player.

TRANSISTORS AS AMPLIFIERS

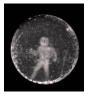
electronics.stackexchange.com : tinyurl.com/y49u5ala



NPN emitters are negative, PNP emitters are positive. Used in valve circuits the power supply to PNP transistors seems to be upside down. This diagram shows the same common-emitter amplifier circuit using an NPN transistor (a) and a PNP transistor (b). The polarity of the battery and electrolytic capacitors are reversed, but otherwise the circuits are identical. When



carrying out voltage measurements with an analogue meter, you will need to connect the negative probe to the ground rail for the NPN circuit and the positive probe to the ground rail for the PNP circuit. A digital meter will just read positive or negative as appropriate. Nearly all early transistor radios use germanium PNP transistors. NPN and PNP circuits for the two are similar, however the polarity is the opposite way around.



Dolphin echolocation from Digitally enhanced hydrophone A.K.A a Cymatron youtube.com/watch?v=-vWIYteyF7I

Cymatic instrument design using rubber over a pot, easily dustable with rice grain or powder, spout blown through like a trumpet.

DIY HYDROPHONE

Piezoelectric crystal wafer plates glued and soldered in tin can pick up vibrations. The stereo assembly is meant to receive a deep oceanic sound. Consider inductor coils as another way to pick up vibrations from liquids. Other shapes such as triangles or exotic metal materials. flypaper.soundfly.com tinyurl.com/y4bm5wxr

Make an Infrasound Microphone <= 20Hz

sites.google.com/site/appliedbiophysicsresearch/sound/infrasound/infrasound-microphone

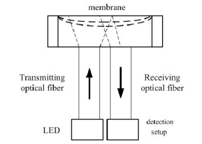
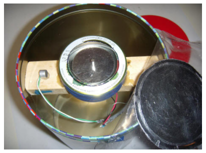
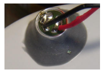


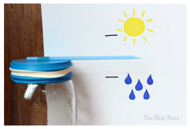
Figure 1. Principle of the infrasound sensor

Design and build an "infrasound" microphone, a "cansformer", I suppose. Sound wavelengths (λ) below the threshold for human hearing need large diaphragms to catch the full signal. Elephant ears are big and are rumoured to hear a tsunami miles away. **Materials** : Tin Can x2, 1 large, and 1 small. Plastic diaphragm scavenged from a zipper bag comforter. Soft rubber also works (perhaps from a toy tom-tom drum). Epoxy or Glue. Wood. Interpret the data using http://spek.cc/. This "far infrasound" microphone amplifies a Motorola MPX100A transducer output pressure (see techlib.com : tinyurl.com/m9bjp3r). The transducer may be an electret Panasonic WM-034BY for its unusually low frequency (Hz) response. Playing data back sped up brings the sound into hearing range. **Methodology** : The tin lid has a hole cut center to let sound in. Soft plastic diaphragm is stretched and glued over empty can. A disc cut from the tin can is glued to the soft plastic diaphragms center, acting as a stiffener. This catches low wavelength sound. Glue applied underside to the diaphragm edge makes a good tight seal when forcing the lid. If the hole in the mint lid is big enough, the steel disk may be glued into position after the diaphragm is stretched. Next photo shows the diaphragm peeled back, revealing the smaller tin stretched over with another soft plastic diaphragm mounted on a wood strip. The smaller diaphragm has a disk glued center. Electret microphone is mounted with epoxy over a small drilled hole in the smaller can so that it is exposed to the larger can inside. (Microphone glued to wood is there for pressure wave comparison)



A magnet holds together the two metal discs at center, making lid removal possible. A straight edge across the big can mouth helps position the magnet top. The metal stiffener will move up and down to large wavelength pressure changes proportional to the can height. Smaller can pressure changes are multiple to the larger can and transformation gives more audio volume, therefore, better signal-to-noise ratio. Can has a pinhole to allow the pressure to slowly equalize. The prototype happened to have a slow leak so no hole was needed. Pressing in the big Diaphragm and releasing results in a 30 second slow return to the flat position. Large diaphragm motion can be hard to see, so temporarily glue a stick and let it rest on the lip of the hole and slight changes will move the stick up and down against a scale. Gain and sensitivity are checked by positioning a large speaker driven by a signal generator set to 15 Hz. Our prototype had an unexpected low x5 gain, due to diaphragm stiffness, especially the smaller one, and the relative can diameters. Second mic glued to the wood gives a x6 gain. Seal the microphone cable connector using potting wax or epoxy. Most sound cards go down to about 20 Hz. One possibility is to use both amplified and low-pass filtered microphone signals to drive a voltage to frequency converter with a center frequency well above the frequency to be monitored, perhaps 2 kHz. This FM modulates the 2 kHz and FFT software can see the variation as sidebands at the center frequency.





Would you like to know more? www.asmrstudio.com DrDoubleDragon@gmail.com

Shinto religious symbol possibly a water cymatic table, also known as scrying

Cymatic-Holographic imaging technique using a chlandi technique